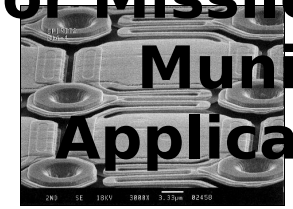
BAE SYSTEMS

Uncooled IR Seekers for Missile and Munitions Applications



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Jim Franciscovich, Margaret Kohin, Ray Silva, Mike Deflumere

BAE SYSTEMS
Information & Electronics Warfare Systems
Lexington, MA and Nashua, NH

Outline

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- The Enabling Technology: Uncooled IR Imager

- App
  - Pr

Uncooled IR Overview

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- Historically Infrared Missile Seekers were based on Cooled Detectors
  - Relatively Complex, Large and Expensive
  - These attributes limited the suitability for munitions applications
- Recent Developments in Uncooled Technology have established this as a Technically Competitive, Low Risk and Cost Competitive Candidate for IR Seeker Missile and Munitions Applications
  - Technically Competitive
    - Sensitivity, Frame Rate and Integration Time Constants meet Mission Requirements
    - Large Format Small Pixel Arrays = Very Compact Package Size
  - Low Risk
    - Seeker Rated at TRL 6
    - Focal Plane Devices In Volume Production Today
  - Cost Competitive
    - Large Commercial Market Base
    - Eliminates Cooler and Associated Hardware

BAE SYSTEMS Low Cost Uncooled Microbolometers Performance challenges conventional higher cost cooled seekers for missile and munitions applications

The Technology Enabler: Low Cost, Small Pixel, Uncooled MICROIR™ Microbolometer Technology

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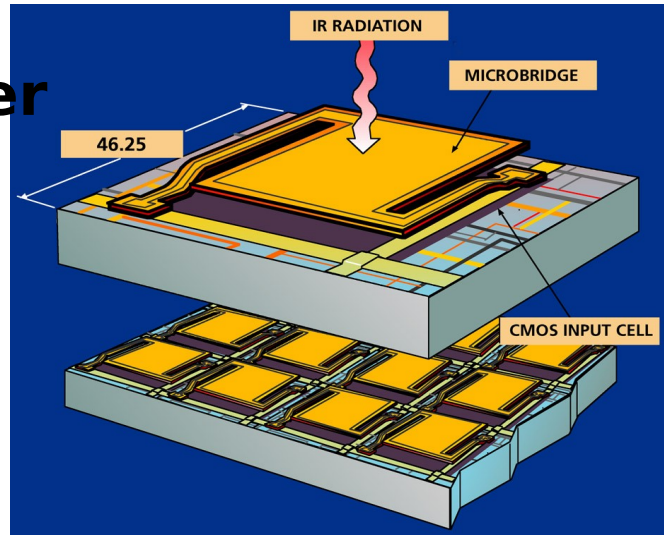
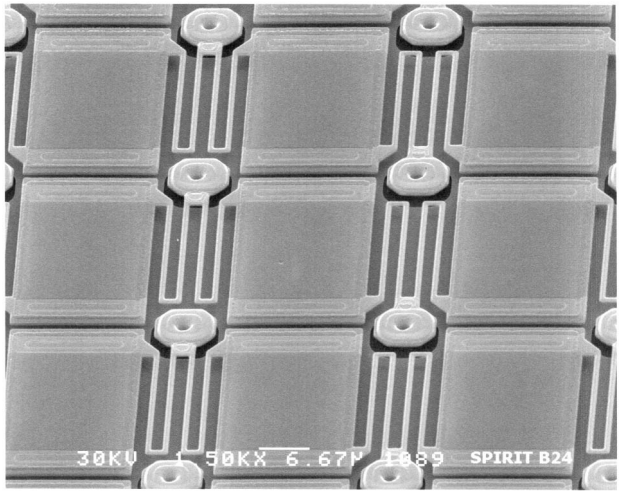
- Principle of operation
  - IR radiation heats thermally isolated microbridge
  - Vanadium Oxide (VO_x) bridge material has high Temperature Coefficient of Resistance (TCR)
- Characteristics
  - LWIR (7 – 14 µm) sensitivity
  - BAE SYSTEMS has on-chip 14 bit ADC's for
    - reduced sensitivity to outside noise sources
    - reduced system complexity
    - extremely wide dynamic range (DR)
      - DR > 160°C w/system NETD <50mK from -40 to +85 °C
  - Short thermal time constant: 4 - 15ms typical
- Advantages
  - Low Cost
  - Good Sensitivity
  - No Cooler or Scanner
  - High Reliability
  - Very Lightweight
  - No Scan Converter Electronics
  - "Near Instant" On (<10 Seconds) Operation





Recent 640 x 480 FPA with NETD <50 mK (F/1, 30 Hz)

BAE SYSTEMS Has World Class MICROIR™ Uncooled Capability

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BAE SYSTEMS Has Shipped Over 17,000 Uncooled IR Microbolometer Imaging Modules & Systems

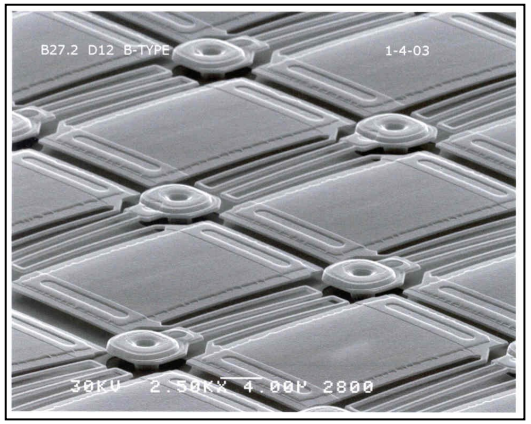
- Single Shift Production Deliveries > 1000 units/month (6-inch line)
- High quality, reliable, on-time (>99% since 2002) delivery
- Current production orders for small pixel based products
- Continuously operating uncooled foundry and key personnel since 1995

Ultra High Performance Uncooled Small Pixel FPAs Demonstrated

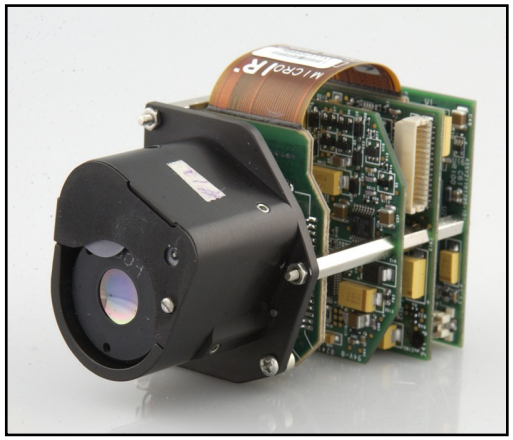
- Sensitivity (σ_{tvh}) of < 50 mK, F/1 demonstrated

Results of 10-years of Dual-Use Technology

- Investment Shared by Commercial Customers
- Product Prices are Reduced
- Production Capacity has Increased
- Product Reliability has Improved
- Export Controls are Built-in (Anti-Tamper)



Microbolometer Structure with 0.3 µm wide thermally isolating legs



Standard Camera Core 500 (SCC500)

IR Seeker Based on MICROIR™ SCC500™ Infrared Module Family

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SCC500 KEY PERFORMANCE PARAMETERS			
	SCC500L	SCC500H	SCC500X
Resolution	160 x 120	320 x 240	640 x 480
Pixel Pitch	46 µm	28 µm	28 µm
Operating temperature	-40 to +85C	-40 to +85C	-40 to +85C
Power	2.0 to 2.5W*	2.0 to 2.5W*	2.75 to 3.25W*
Voltage	Single Input 5.5 - 12.8 VDC		
Frame/field rate	60/60 Hz	60/60 Hz	30/60 Hz, 60/60 Hz optional
Elec. Latency	< 0.2 ms	< 0.2 ms	< 0.3 ms
Weight (w/o optics)	83g	83g	126g
Weight (incl. optics)	162g (0.36 lbs)	162g (0.36 lbs)	162g + larger optics
System Sensitivity	50 mK	50 mK	Optics dependent
Optics	F/1, 44 deg HFOV	F/1, 54 deg HFOV	

* Power is for operation at full frame rate with simultaneous analog & digital video

- **Standard Camera Core (includes optional optics)**
- **Flexible front end cable permits wide range of system installation options**
- **Digital (8 or 16 bit) and Analog (RS-170) video output**
- **Size (w/optics) SCC500 Size = 8.1 x 4.8 x 4.3 cm (3.2 x 1.9 x 1.7 in)**
- **Size (w/o optics)**

Product Family Approach Maximizes Seeker Applications while providing Economy of Scale Benefits

High Resolution Images Meet Target Acquisition Requirements

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UNCOOLED TECHNOLOGY IS IMPROVING BOTH AFFORDABILITY AND EFFECTIVENESS FOR MILITARY PROGRAMS

Uncooled Seeker Trade Space Meets a Wide Range of Application Requirements

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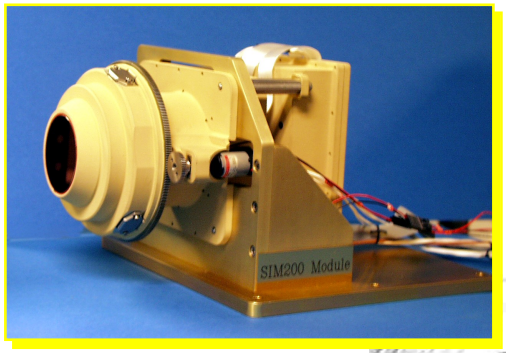
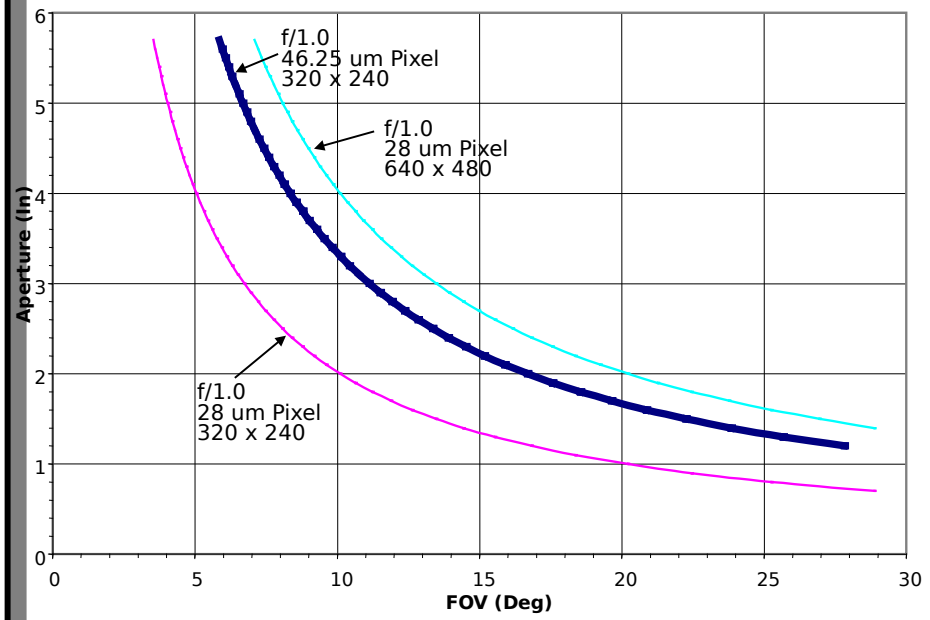
Stapdown ⟷ **Gimballed**



Field of View Vs Aperture Size



Uncooled Technologies Compact Size Increases Weapon System Options

Uncooled Seeker Benefits

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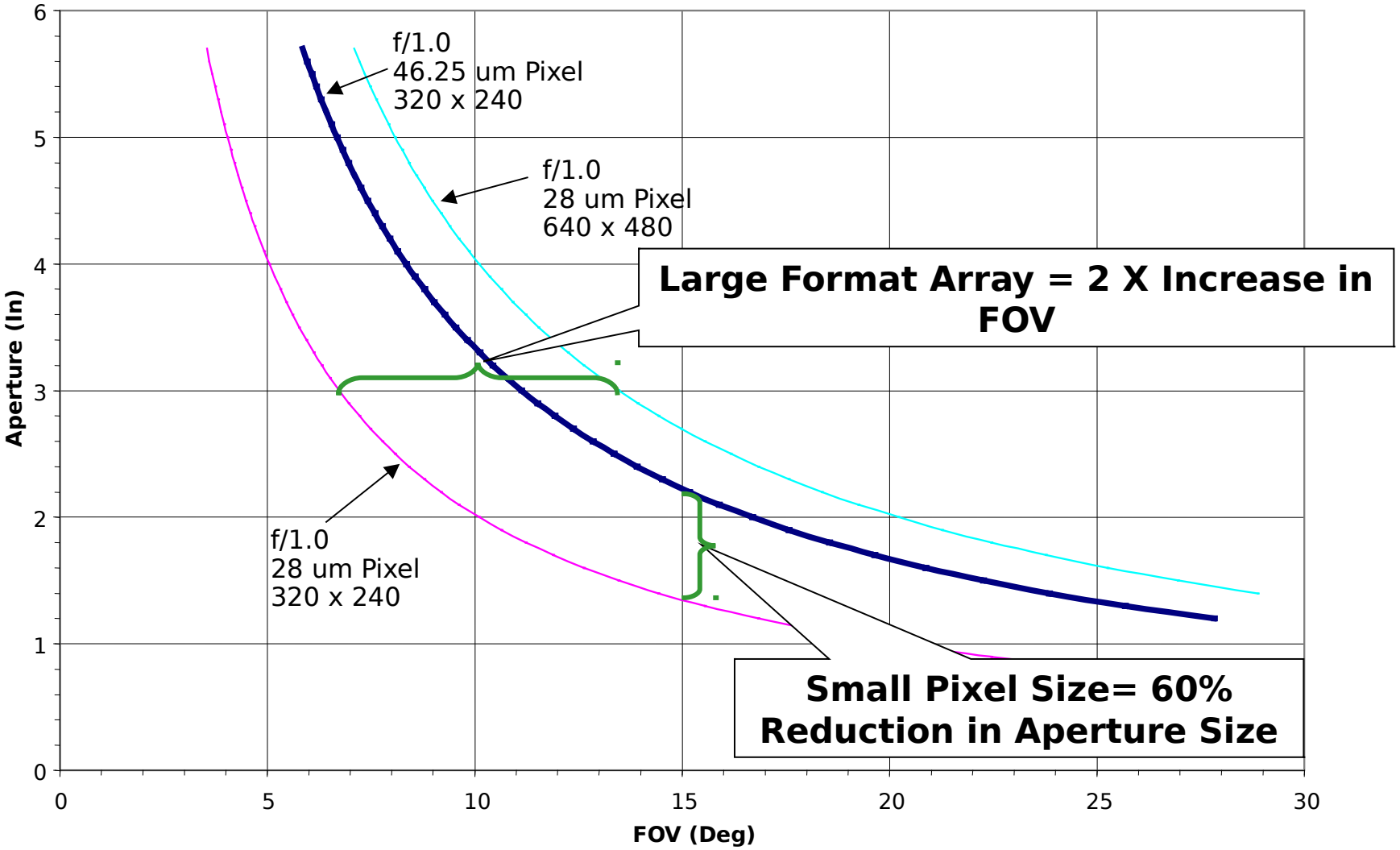

Product Family is applicable to a wide range of Mission Requirements and Available Size

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Application Example: IR Seeker on Guided Munition

- Objectives
  - Complete real-time, through the weather, reactive strike against mobile or popup targets
  - Improve CEP
- Approach
  - Add IR terminal seeker
  - Use GPS and IR template matching to achieve CEP

Technology Enabling Affordable Reactive Targeting

A Typical Mission

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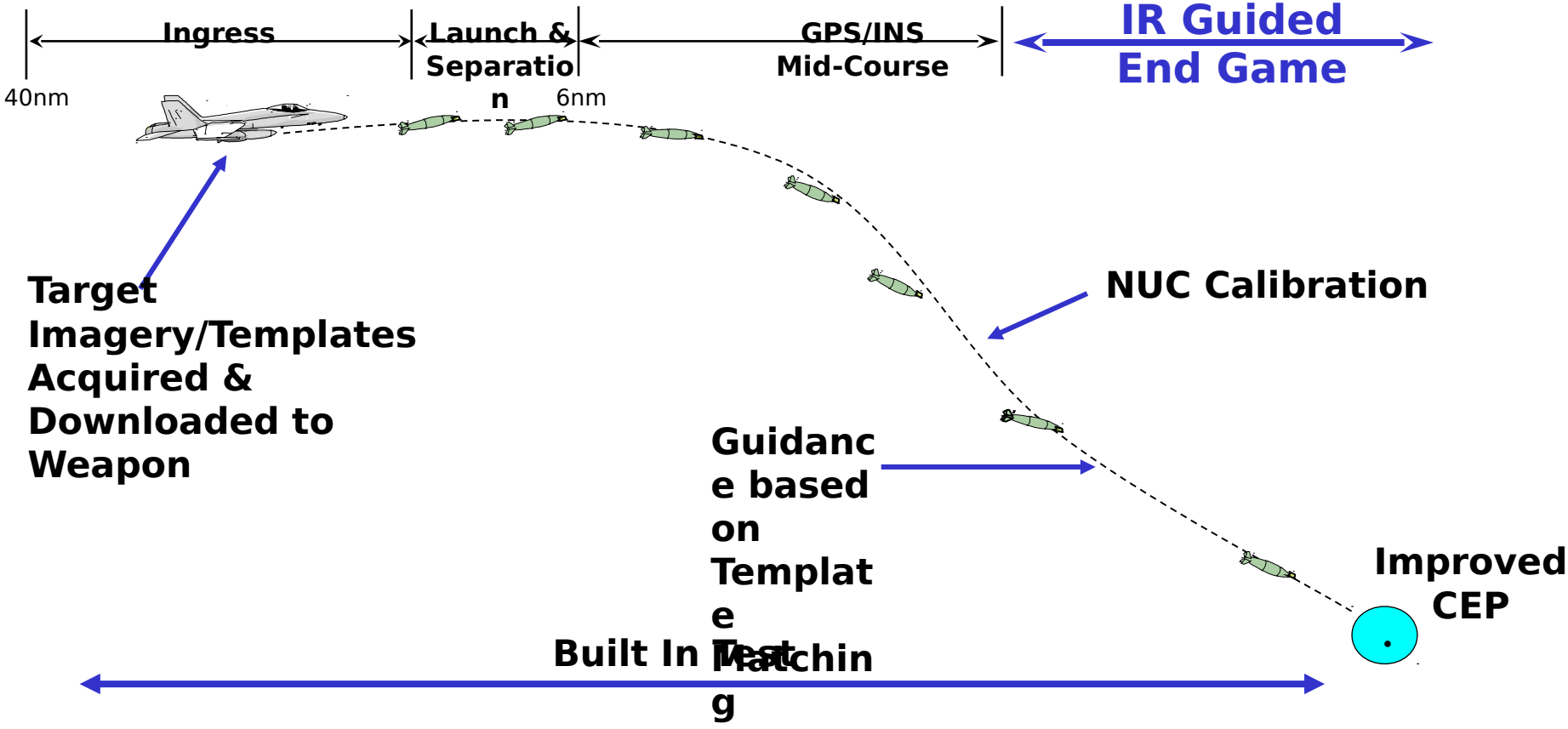

Adding an Affordable IR Seeker capability improves the weapons CEP allowing a significant reduction in the # A/C sorties (and pilots exposure) while reducing the potential for fratricide and collateral damage

Key System Trades Used to Define Seeker Architecture

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- **Positioning method**
  - ***Gimbal positioner*** **selected over rotating wedges**
  - **Provides highest transmission, reduced LOS stabilization requirements, and lowest risk**
- **Environmental Enclosure**
  - ***Dome*** **selected over window**
  - **Provides lowest drag, largest volume for sensor, and best optical performance**
- **IR waveband**
  - ***LWIR*** **selected over MWIR**
  - **Provides best performance in poor weather, in presence of obscurants, or with solar glint; provides higher signal**
- **Detector Technology**
  - ***Uncooled*** **selected over cooled**
  - **Provides capability for frequent end-to-end BIT, lowest cost, lowest complexity, long lifetime, higher reliability, rapid turn-on time, and widest operating temperature range**
- **Detector Type**
  - ***Microbolometer*** **selected over ferroelectric**
  - **Provides dramatically smaller system, better sensitivity, and has no chopper**

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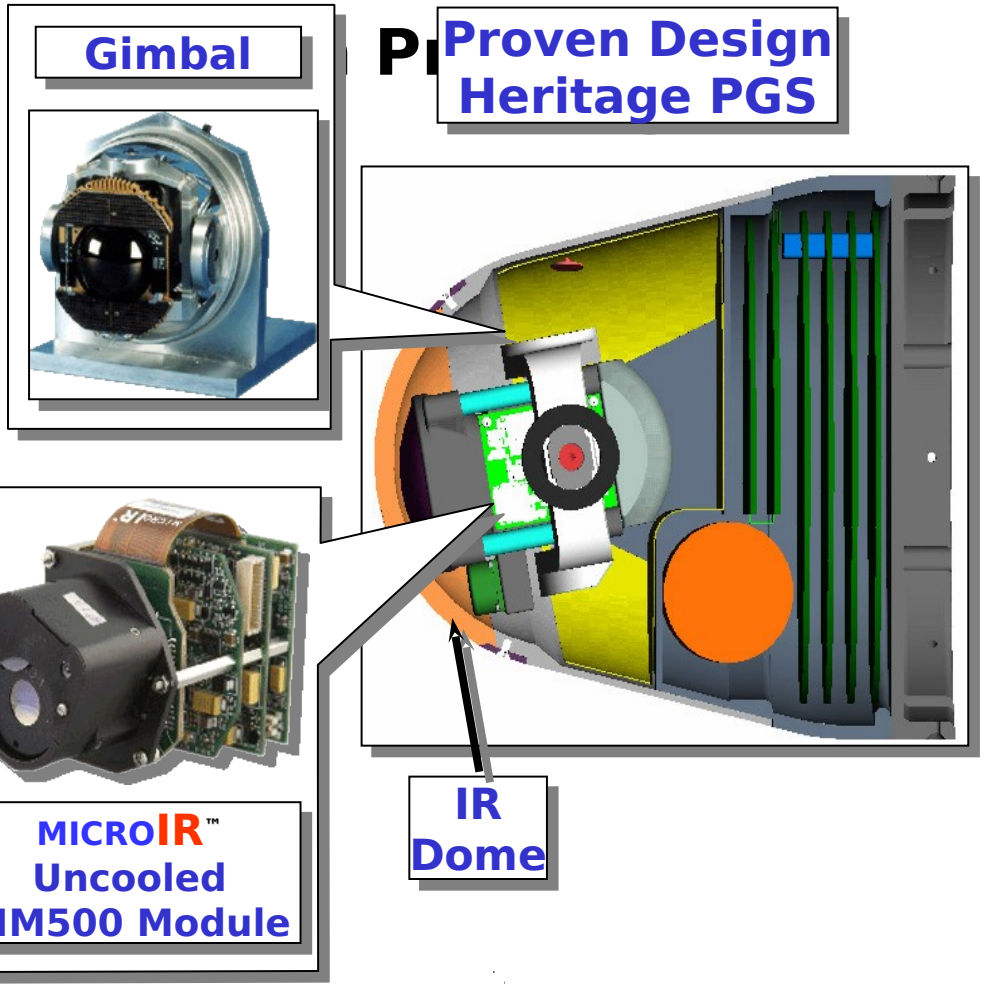
BAE SYSTEMS IR Seeker Meets All Is Pr

Hardware

SCC500 PERFORMANCE	
Resolution	320 x 240
Pixel Pitch	28 micrometers
Optics	Athermalized
Sensitivity	< 50mK @ f/1.0
Field / Frame rate	60 / 60 Hz
Operating Temperature	-40 to +85 degrees centigrade
Power	2.0 - 2.5 Watts
Voltage	5.5 - 12.8 VDC
Ready time	< 10 seconds



Our Design Features Reflect a Strong Seeker Heritage

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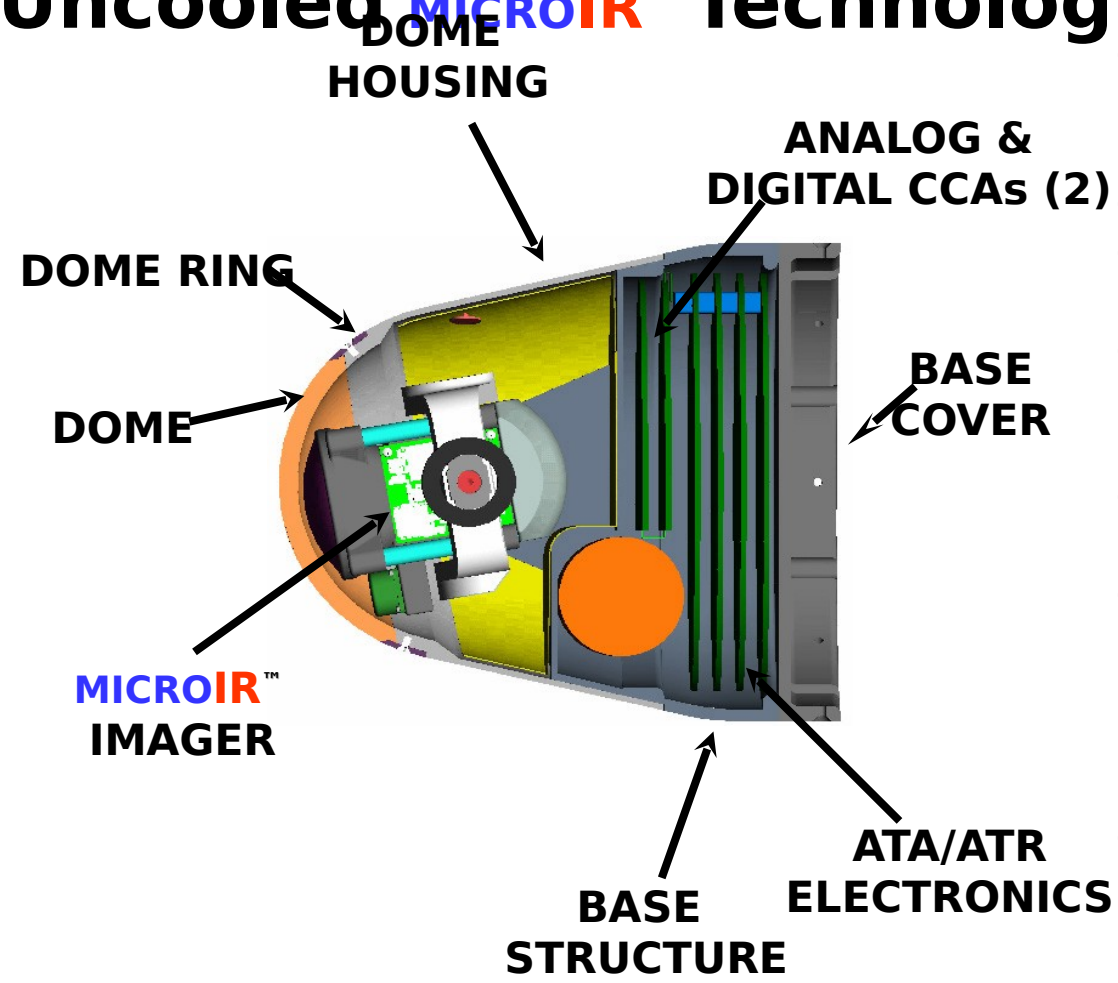
IR Seeker is Based on Low Cost Uncooled MICROIR™ Technology



- Key Sensor Features
  - Low-Cost in-Production MICROIR™ Uncooled Imaging Module
  - Proven 2-Axis Gimbal
  - High-Coverage Through-the-Lens BIT
  - Sealed Optical Compartment Extends Life and Avoids Condensation
  - No Gas or Other Expendables
  - Unlimited Cycles of Full Operation Provides Availability Through Storage and Mission Timelines
  - Highest power CCAs at rear of system for better heat dissipation

Summary

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- **Outstanding Performance**
  - Meets Precision Effects Requirements
- **Compact Package Size**
  - Enables Single & Multi Mode Configurations
- **Elimination of Coolers**
  - Improves Availability
  - Reduces Ownership Costs
- **In Volume Production Now**
  - Low Risk
  - Cost Competitive

The VoX Based Uncooled IR Technology's Price Performance Point has Redefined the Ability to Provide Low Cost Precision Effects

"We will not tire,
we will not falter,
we will not fail."

... as we work to

Protect Those Who Protect Us

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